

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

WO 00/30773

2 June 2000 (02.06.00)

(51) International Patent Classification 7 :  
B08B 9/04

A1

(11) International Publication Number:  
(43) International Publication Date:

(21) International Application Number: PCT/GB99/03907

(22) International Filing Date: 24 November 1999 (24.11.99)

(30) Priority Data: 24 November 1998 (24.11.98) GB  
9825714.0

(71) Applicant (for all designated States except US): HAMDEEN LIMITED [GB/GB]; Birkdale House, 7 Myrtle Street, Douglas, Isle of Man IM1 4ED (GB).

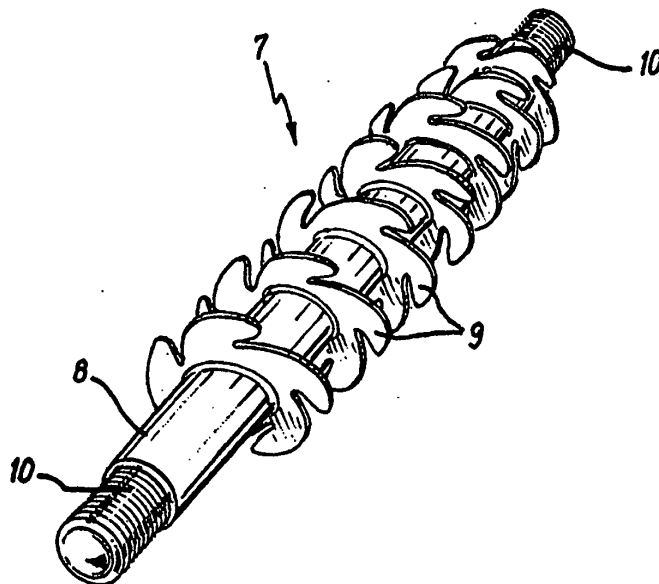
(72) Inventor; and  
(75) Inventor/Applicant (for US only): LAKER, Keith [GB/-]; 1 Piersteps, St Peter Port, Guernsey GY1 2LF (GB).

(74) Agent: KENNEDY & CO.; Queens House, 4th floor, 29 St Vincent Place, Glasgow G1 2DT (GB).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published  
With international search report.

(54) Title: PIPELINE PIG



(57) Abstract

A pig (1) for use with a tubular bore wherein the pig (1) is comprised of a body (2) which supports a plurality of turbine blades (3) wherein the blades (3) mechanically break down and remove debris from the tubular bore. The blades (3) have a profile which allows forward movement and rotation about a longitudinal axis when acted upon by a propulsion fluid travelling through the tubular. In an alternative embodiment the blades are mounted on a stabiliser body to allow simultaneous centralisation and cleaning.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

1                    PIPELINE PIG

2  
3    This invention generally relates to mechanical pigging  
4    devices, commonly referred to simply as "pigs", for use  
5    in pipelines or other tubulars. Such pigs are known to  
6    find utility in a diverse range of applications,  
7    including for cleaning purposes and for conveying  
8    equipment in the case, for example, of pipeline  
9    monitoring. In the present invention there is described  
10   a unique pig suitable for use in the cleaning of internal  
11   surfaces of a pipeline or tubular and, in a variation  
12   thereof, suitable for applying coatings or other fluids  
13   to the aforesaid surfaces.

14  
15   It is known in the art to cause cleaning pigs to be  
16   propelled through a pipe or tubing under the influence of  
17   a pressurised fluid. Pigs, designed for this purpose,  
18   typically have a flexible cylindrical body made, for  
19   example, from a polyurethane foam. Other materials have  
20   also commonly been used, including rubber, metal,  
21   plastics and combinations and composites. The rear and  
22   front end walls of the cylindrical body may be covered  
23   with an impervious coating designed to form a moving seal  
24   with the inner wall of the pipe. With this design, the  
25   pig essentially acts as a piston as it is conveyed  
26   through the pipeline or tubular; the fluid on its rear  
27   side having a higher pressure head than the fluid at its  
28   front side.

29  
30   Notably, pigs propelled through pipelines or the like in  
31   the manner described above are intended to prevent  
32   propelling fluid from flowing through or around the pig.  
33   Implicated by this, pigs used for cleaning purposes have,  
34   in the past, been intended to physically push and

1 forceout debris in advance of the pig as it travels  
2 through the pipe bore. At best, the pig itself provides  
3 an additional wiping function on the pipe walls.

4  
5 In the present invention it is recognised that, on  
6 occasion, it would be advantageous to provide a more  
7 rigorous cleaning process to a pipeline bore than merely  
8 pushing loose debris and wiping the surfaces. In the  
9 art, those who have addressed this problem have  
10 contemplated the provision of scratching elements, such  
11 as wire bristles, on the circumferential walls of the  
12 pig. While related designs provide for a more aggressive  
13 cleaning process, such pigs usually do not allow for  
14 sufficient fluid flow past the bristles to allow for the  
15 bristles themselves to be cleaned. In use, debris,  
16 shavings, slivers and the like can become lodged between  
17 the bristles, serving to reduce the efficiency of the  
18 pig's travel and the cleaning process.

19  
20 An object of the present invention is to obviate or at  
21 least mitigate these and other disadvantages associated  
22 with pipeline or tubular cleaning pigs. In one aspect,  
23 the invention seeks to achieve this by creating an  
24 alternative means for the propulsion of the pig through  
25 the pipeline or other tubular.

26  
27 A further object of the invention herein is to employ the  
28 novel propulsion features disclosed herein in relation to  
29 pigs for use in respect of other functions, including  
30 pigs intended to act as mechanical applicators.

31  
32 According to a first aspect of the present invention  
33 there is provided a pig for use in a tubular bore,  
34 wherein the pig is provided with one or more blades

1 having a profile that encourages both forward movement  
2 and rotation about a longitudinal axis of the pig when  
3 acted upon by a propulsion fluid travelling through the  
4 tubular.

5

6 It is envisaged that the pig may comprise of a  
7 cylindrical elongate body having an outer diameter less  
8 than the internal diameter of the tubular, wherein the  
9 body supports a plurality of blades.

10

11 Preferably, the pig is a cleaning pig and the peripheral  
12 edges of the blades are adapted to perform a cleaning  
13 function as the pig rotates and travels through the  
14 tubular. More particularly, the blades of the pig are  
15 designed to scrape the internal surfaces of the tubular  
16 bore upon the rotation and passage of the pig. An  
17 advantage may be obtained in the option of providing the  
18 edges in an abrasive material. Similarly, the edges of  
19 the blades may be provided in a material that is  
20 relatively hard and therefore resistant to wear.

21

22 Preferably the blades are provided in composite, such as  
23 kevlar, carbon, glass fibre, although any other suitable  
24 material may be used.

25

26 Alternatively, however, the peripheral edges may be  
27 adapted to perform alternative functions. For example,  
28 the pig may be provided as a means for the mechanical  
29 application of a coating or fluid to a tubular bore and,  
30 optionally, the blades or at least the edges thereof may  
31 support a suitable applicator material having a high  
32 capacity for carrying by absorption or other means the  
33 coating or fluid to be applied.

34

1 According to a second aspect of the present invention  
2 there is provided a pig for use in a tubular, wherein the  
3 pig is comprised of a stabiliser body wherein the  
4 stabiliser body supports a plurality of blades and is  
5 conveyed mechanically through a tubular.

6  
7 Preferably the pig is a cleaning pig wherein the blades  
8 of the pig are designed to scrape the internal surfaces  
9 of the tubular bore whilst the stabiliser body provides  
10 centralisation.

11  
12 Preferably the blades may be adapted so that they do not  
13 exhibit any abrasive qualities thereby reducing the risk  
14 of damage if the pig is to be used in tubing which is  
15 plastic coated.

16  
17 Preferably the blade properties can be pre selected to be  
18 adapted to flex through a profiled restriction in the  
19 tubular bore thereby providing a means of confirming the  
20 position of a pig within the tubulars.

21 According to a third aspect of the present invention  
22 there is provided a pig for use in a tubular, wherein the  
23 pig is adapted to rotate in its longitudinal axis under  
24 the influence of a propulsion fluid as it is displaced  
25 through the tubular.

26  
27 The pig may be further adapted to rotate in orbit within  
28 the tubular bore.

29  
30 According to a fourth aspect of the present invention  
31 there is provided a pig for use in a tubular, the pig  
32 comprising reaction surfaces adapted for forward  
33 propulsion of the pig under the influence of a positive  
34 pressure applied by propulsion fluid travelling through

1 the tubular, characterised in that the reaction surfaces  
2 are spaced and orientated so as to provide for a net  
3 positive velocity of the propulsion fluid relative to the  
4 pig in the direction of travel through the tubular.

5

6 The reaction surfaces may be provided on a plurality of  
7 respective blades, such as turbine blades. Preferably,  
8 the blades define a fluid by-pass path, the blades being  
9 separated by void areas which permit the relative flow of  
10 fluid through the pig in a forward direction.

11

12 Preferably the reaction surfaces also encourage the  
13 rotation of the pig around its longitudinal axis when  
14 acted upon by the propulsion fluid.

15

16 According to a fifth aspect of the present invention  
17 there is provided a pig for use in a tubular, wherein the  
18 pig is provided with one or more blades having a profile  
19 that precludes rotation of the pig while travelling  
20 through the tubular.

21

22 The blades are typically of varying diameter, the largest  
23 blade or blades potentially, having a diameter greater  
24 than the internal diameter of the tubular.

25

26 Preferably the largest blade or blades are sufficiently  
27 flexible to allow entry and passage of the pig through  
28 the tubular yet sufficiently robust to carry out and  
29 withstand the rigours of the cleaning process.

30

31 It should be understood that references to tubulars  
32 herein, unless the context otherwise dictates, should be  
33 construed in the broadest possible sense, and interpreted  
34 to encompass any form of tubing, pipe or pipeline.

1

2 In order to provide a better understanding of the  
3 invention, example embodiments of a pig incorporating the  
4 invention will now be described with reference to the  
5 accompanying Figures;

6

7 Figure 1 shows, in perspective view, a pig intended for  
8 the cleaning of the internal surfaces of coiled tubing as  
9 the pig is propelled along the tubular by a propulsion  
10 fluid.

11

12 Figure 2 shows, in perspective view, a pig intended to  
13 provide stabilisation and cleaning of the internal  
14 surfaces of tubing as the pig is conveyed mechanically  
15 along a tubular.

16

17 Referring firstly to Figure 1, a pig, generally depicted  
18 at 1, comprises substantially of a body 2 and a plurality  
19 of turbine blades 3. The body 2 is generally elongate  
20 and cylindrical. The pig body 2 is suitably made of a  
21 robust material in view of its need to withstand  
22 substantial impact loads, while also functioning in an  
23 aggressive cleaning manner.

24 The blades 3 are afforded a turbine or impeller like  
25 profile, having reaction surfaces 4 that react to the  
26 influence of a propulsion fluid pumped through the coiled  
27 tubing in which the pig 1 is intended to travel. Typical  
28 of turbine blades, the blades 3 can be provided on the  
29 body 2 such that the reaction surfaces 4 are presented at  
30 an acute angle to the linear direction of the fluid flow,  
31 thereby imparting a reaction torque to the body 2 in  
32 addition to a reaction force in the axial direction. In  
33 consequence, the pig 1, when acted upon by a propulsion  
34 fluid, is caused to travel through the coiled tubing in a



7

1 generally axial direction, but to also rotate about its  
2 longitudinal axis while so doing.

3

4 Additionally, the pig 1 moves in a third dynamic path.  
5 The outside diameter of the pig 1 can be sized to have a  
6 degree of clearance within the internal bore of the  
7 tubular. That is to say, the maximum outside diameter of  
8 the pig is less than the internal diameter of the  
9 tubular, allowing for radial displacement of the pig 1  
10 during its travel through the tubing. In fact, it is  
11 recognised in the present invention, that such  
12 dimensioning of the pig 1 relative to the tubing causes  
13 the longitudinal axis of the pig 1 to orbit or rotate  
14 about the substantially parallel longitudinal axis of the  
15 tubing.

16

17 This third dynamic path is associated with a number of  
18 advantages. For instance, where it is intended that the  
19 peripheral edges 5 of the blades 3 contact the internal  
20 surfaces of the tubing, the radial displacement of the  
21 pig 1 as it orbits around the longitudinal axis of the  
22 tubing allows for such contact over a range of tubing  
23 diameters. This means that it is not essential that a  
24 respective pig, incorporating the invention hereto, need  
25 be provided to correspond to each size of coiled tubing  
26 or other tubular.

27

28 In an alternative application a pipeline can be cleaned  
29 using a combination of two pigs. The first pig, having  
30 an outer diameter less than the internal diameter of the  
31 tubular, passes through the pipeline removing major  
32 restrictions. The second pig removes additional debris  
33 and in effect polishes the internal surface of the  
34 pipeline.

1

2 A further advantage, which applies also to the other  
3 rotational movement of the pig about its own axis, is  
4 that the relative velocity of the blade edges 5 is  
5 considerably higher relative to the tubing surfaces than  
6 that of a pig merely designed for linear movement. This  
7 is particularly advantageous where the pig is intended  
8 for use as a mechanical cleaning device.

9

10 The cleaning pig 1 is designed to clean the internal bore  
11 of coiled tubing. More particularly, the pig 1 is  
12 adapted to apply a rotational cleaning action suitable  
13 for removing scales and other deposits located on the  
14 internal surfaces of the tubing.

15

16 In one use, the pig may be used to prepare the surface of  
17 a tubular, by removing scale or rust not removed by other  
18 cleaning methods, prior to the application of a coating  
19 fluid or material.

20

21 Secondary cleaning of the coiled tubing is achieved by  
22 the effects of disturbances in the flow of the propulsion  
23 fluid through the voids between the turbine blades 3.

24

25 The interaction of the turbine blades with the propulsion  
26 renders the propulsion fluid flow of a turbulent nature.  
27 It will be appreciated by those skilled in the art that  
28 this enhances the cleaning efficiency of the device.

29

30 Furthermore, the presence of voids between the blades 3  
31 results in the propulsion fluid having a positive  
32 velocity relative to the pig. As a consequence of this  
33 positive velocity the propulsion fluid also removes the  
34 debris created by the cleaning of the coiled tubing. The

1 removal of this debris has the advantage of preventing  
2 the build up of potential blockages in the coiled tubing.  
3 Moreover, debris is also cleaned from the blades of the  
4 pig itself.

5

6 In an alternative embodiment the reaction surfaces 4 and  
7 most particularly peripheral edges 5 of the blades 3 are  
8 provided with a material suitable for the application of  
9 a coating of other fluid material.

10

11 With reference to Figure 2, an alternative embodiment of  
12 the present invention generally depicted at 7 comprises a  
13 stabiliser body 8 which has a plurality of blades 9  
14 mounted in a similar configuration to the embodiment  
15 shown in figure 1. The stabiliser body 8 has coupling  
16 means 10 which allow attachment to mechanical driving  
17 means (not shown) so that the stabiliser body 8 is  
18 propelled through a tubular. Where the tubular is casing  
19 or liner in a well-bore, the mechanical driving means may  
20 be a pipe string, for example. Furthermore the blades 9  
21 are mounted on the stabiliser body 8 in a watermelon  
22 shaped configuration which assists entry into and  
23 retrieval out of profiled restrictions.

24

25 In this manner the embodiment shown in Figure 2 allows  
26 simultaneous centralisation and cleaning for coiled  
27 tubing.

28

29 Further modifications and improvements may be  
30 incorporated without departing from the scope of the  
31 invention herein intended.

1

2 Claims:

3

4 1. A pig for use with a tubular bore, wherein the pig  
5 is provided with one or more blades having a profile  
6 that encourages both forward movement and rotation  
7 about a longitudinal axis of the pig when acted upon  
8 by a propulsion fluid travelling through the  
9 tubular.

10

11 2. A pig as claimed in Claim 1 wherein the pig is  
12 comprised of a cylindrical elongate body having an  
13 outer diameter substantially less than the internal  
14 diameter of the tubular, wherein the body supports a  
15 plurality of blades.

16

17 3. A pig as claimed in any one of the preceding Claims  
18 wherein the blades are designed to scrape the  
19 internal surfaces of the tubular bore upon rotation  
20 and passage of the pig.

21

22 4. A pig as claimed in any of the preceding Claims  
23 wherein the pig may be adapted to act as a means for  
24 the mechanical application of a coating or a fluid  
25 to a tubular bore.

26

27 5. A pig as claimed in any one of the preceding Claims  
28 wherein the blades are afforded a turbine or  
29 impeller like profile and have reaction surfaces  
30 adapted for the forward propulsion of the pig under  
31 the influence of a positive pressure applied by  
32 propulsion fluid travelling through the tubular.

33

- 1 6. A pig as claimed in any one of the preceding Claims  
2 wherein the blade design allows sufficient fluid by-  
3 pass to allow the debris removed from the tubular  
4 bore and suspended in the pumped fluid to be flushed  
5 ahead of the pig.  
6
- 7 7. A pig as claimed in any one of the preceding Claims  
8 wherein the blades are shaped in such a manner that  
9 they are separated by void areas which permit the  
10 relative flow of fluid through the pig in a forward  
11 direction.  
12
- 13 8. A pig as claimed in any one of the preceding Claims  
14 wherein the blades are of varying diameter.  
15
- 16 9. A pig as claimed in any one of the preceding Claims  
17 wherein the largest blade has a diameter greater  
18 than the internal diameter of the tubular.  
19
- 20 10. A pig as claimed in Claim 9 wherein the largest  
21 blade is sufficiently flexible to allow entry and  
22 passage of the pig through the tubular.  
23
- 24 11. A pig for use with a tubular bore, wherein the pig  
25 is comprised of a stabiliser body having means for  
26 connection to a mechanical driving means, which  
27 supports a plurality of blades, each blade having a  
28 fixed diameter, wherein the combination of blades  
29 have a watermelon shaped profile.  
30
- 31
- 32 12. A pig as claimed in Claim 11 wherein said pig  
33 provides simultaneous centralisation and scraping of

12

1 the internal surfaces of a tubular as the pig is  
2 conveyed mechanically through the tubular.

3

4 13. A pig as claimed in Claims 11 and 12 wherein the  
5 blade properties are selected to be adapted to flex  
6 through a profiled restriction in the tubular bore  
7 thereby providing a means of confirming the position  
8 of the pig within the tubulars.

9

10 14. A pig as claimed in any of the preceding Claims  
11 wherein the blades are provided in a material that  
12 is relatively hard and resistant to wear.

13

14 15. A pig as claimed in any of the preceding Claims  
15 wherein the blades are manufactured from composite,  
16 such as kevlar, carbon or glass fibre.

17

18 16. A pig as claimed in any one of the preceding Claims  
19 supported on a pipe string in a well-bore.

20

21

22

23

24

25

26

27

28

29

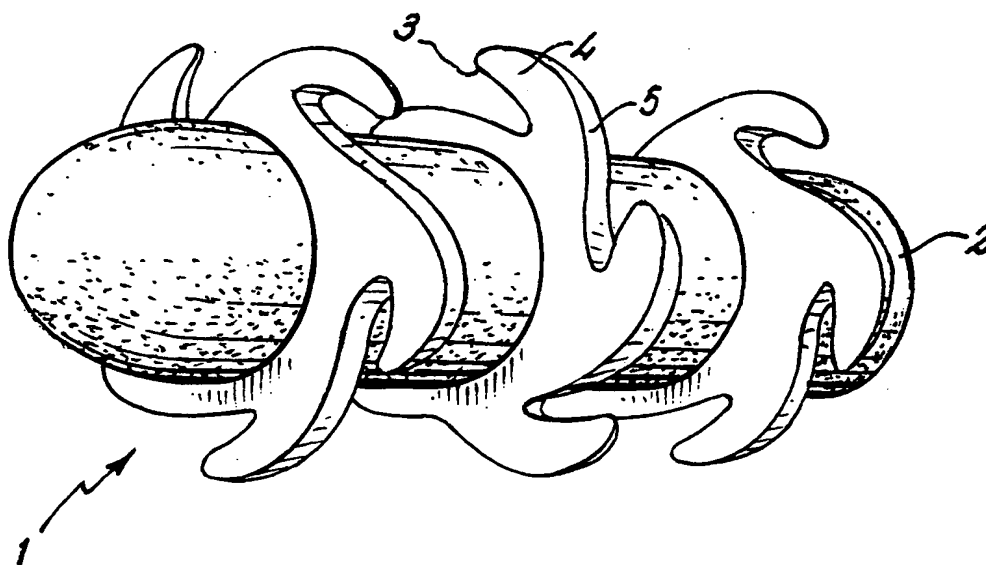
30

31

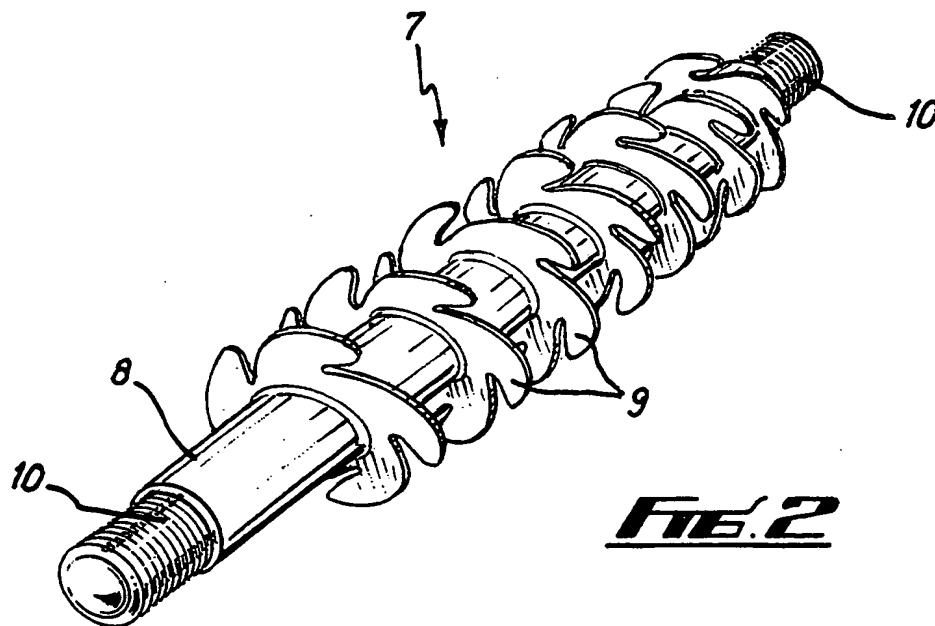
32

33

34



**FIG. 1**



**FIG. 2**

## INTERNATIONAL SEARCH REPORT

Int. Application No

PCT/GB 99/03907

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B08B9/04

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16L B08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 081 875 A (NISHINO EIZO) 4 April 1978 (1978-04-04) the whole document	1,2,5-7
A		3,9,10, 14,15
X	DE 29 44 709 A (RUHRKOHLE AG) 14 May 1981 (1981-05-14) page 6, paragraph 2 figures 2,3	1-3,5,11
A		6-8,14, 15
	— — — — — -/-	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

Date of the actual completion of the international search

8 March 2000

Date of mailing of the international search report

17/03/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5618 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3018

Authorized officer

Schaeffler, C



## INTERNATIONAL SEARCH REPORT

Int. Application No.

PCT/GB 99/03907

## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 379 475 A (SIVACOE ORLANDE) 10 January 1995 (1995-01-10) abstract figure 4 column 2, line 33 - line 65 column 3, line 14 - line 25	1-3, 6, 7, 12-14
A	US 5 600 863 A (CURRAN ED) 11 February 1997 (1997-02-11) abstract figure 1 column 3, line 21 - line 42 claim 1	1, 3, 5, 6, 10
A	US 4 122 575 A (SAGAWA TEIKICHI) 31 October 1978 (1978-10-31) figures 1A, 1D column 3, line 35 - line 43	1

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

Int. Application No

**PCT/GB 99/03907**

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4081875	A	04-04-1978	NONE		
DE 2944709	A	14-05-1981	CH	649011 A	30-04-1985
US 5379475	A	10-01-1995	CA	2099794 A	06-01-1995
US 5600863	A	11-02-1997	US	5528790 A	25-06-1996
US 4122575	A	31-10-1978	NONE		